Open Innovation After Initial Coin Offerings - An Empirical Investigation of Crowd Participation and Third-Party Support

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Short Paper

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Abstract

This study investigates the relationship between third-party support of young ventures and crowd engagement in open source development projects grounded in signaling theory. It is centered on the empirical analysis of a multi-source secondary dataset of 697 firms which conducted an initial coin offering (ICO) and published their source code online. We find that internal third-party support by technology advisors is positively associated with crowd engagement for open source development projects. Contrary to our initial hypothesis, we find internal support by business advisors and prestigious external support to be negatively related to crowd participation. The study enhances our understanding of antecedents of software co-creation and contributes to IS literature on third-party endorsement in open innovation and ICOs.

Keywords: Open innovation, initial coin offering (ICO), signaling theory, third-party support

Introduction

In recent years, initial coin offerings (ICOs), a new way of early-stage venture financing enabled by blockchain technology, have grown to considerable importance. Having attracted over 16 billion USD of funding volume in 2018 (CoinDesk 2019), ICOs offer enormous potential to create social and economic value (Adhami et al. 2018). In ICOs, entrepreneurial ventures raise funding from a crowd of small-scale investors by selling digital tokens for specific projects. The sale is a peer-to-peer online transaction between startup and crowd, validated by blockchain technology (Tapscott and Tapscott 2017). The decentralized, global, and until now largely unregulated nature of this funding method leads to high information asymmetries between ventures and investors (Blaseg 2018; Guske and Bendig 2018; Lipusch 2018).

To bridge this information gap and signal their quality, ICO ventures search support from third parties, such as internal third parties (ICO advisors) or external third parties (independent online experts). In this regard, IPO and crowdfunding research has shown that third-party certification is related to higher funding success (Plummer et al. 2016; Short et al. 2017). Building on these findings, we extend the scope of analysis beyond the fundraising phase and investigate how the support of ICO advisors and independent online experts impacts the venture´s operational development process.

In their software development efforts, many ICO projects pursue an open software development strategy. They publicly reveal their source code to enable the crowd to review development progress online and contribute to the project (Fisch 2019). Related studies show that virtual co-creation is beneficial for firms, as it can improve the success of new products (Füller et al. 2010). Yet, our knowledge of antecedents of co-creation remains rather limited and related quantitative research leveraging secondary data is scarce (Gemser and Perks 2015). In this vein, ICOs with large crowd support in combination with open innovation development projects offer new opportunities for scholars. To date, ICO literature mainly focuses on legal

aspects (Barsan 2017; Nolan et al. 2018) or antecedents of ICO fundraising success (Adhami et al. 2018; Chen 2018; Fisch 2019), but no studies have been carried out which analyze the potential of ICOs to drive product innovation. Closing the literature gap on the link between third-party endorsement and co-creation will help answering the question whether the right partners (internal or external third-party support) can assist ICO ventures in unlocking the full potential of the crowd.

Conducting an empirical analysis of 697 ICOs, our study contributes to information systems (IS) and open innovation literature in three ways. Firstly, we enhance the literature on open innovation by quantitatively investigating the relation between third-party endorsement and product development, thereby extending signaling literature beyond the ICO financing perspective. Here, we provide an empirical study with an objective measure for co-creation. Secondly, we shed light on the different signaling effects originating from internal and external third-party supporters and provide insights about the role of their type and reputation for crowd engagement. Thirdly, we contribute to an emerging research stream on ICOs, which provides new opportunities for studying early phases of ventures and their product development process. We address current voices questioning the value of ICOs (Benedetti and Kostovetsky 2018) by investigating the value-add that this new innovative funding method provides to ventures beyond just the financing.

Literature Review and Hypothesis Development

During their ICO, early-stage technology ventures introduce their product or product idea to a large online crowd to get financing (Chen 2018; Lipusch 2018). Most cryptographic tokens are designed as utility tokens, which enable the buyer access to a service or product offering in the venture´s ecosystem after the development is completed (Arnold et al. 2019; Lee 2018). Often the projects are at an early-stage during the ICO, as the ventures plan to use the collected funding for product development (Arnold et al. 2019).

So far, studies in the emerging research field of ICOs mainly focus on the underlying ICO process and technical mechanisms (Chen 2018; Kaal and Dell'Erba 2018) as well as on legal aspects (Barsan 2017; Nolan et al. 2018) and determinants of ICO success (Adhami et al. 2018; Blaseg 2018; Catalini and Gans 2018; Chod and Lyandres 2018; Fenu et al. 2018; Fisch 2019; Guske and Bendig 2018). Beyond financial motives, ICO investors seem to be driven by technological and ideological motives. About one third of ICO investors have a business education and 22% studied computer science. They inform themselves mainly online about investment projects (Fisch et al. 2018).

To signal their quality and attract investors during their fundraising campaigns, ICO ventures provide information online in project whitepapers and on ICO listing websites (like ICObench.com). They display information about their project, team and support by third parties. Internal third-party supporters are ICO advisors (Amsden and Schweizer 2018), who the ventures introduce to the crowd by providing a link to the advisors´ LinkedIn profiles. Advisors´ interests are aligned with the ICO venture as they are compensated either with tokens during the ICO or traditional compensation forms. External supporters are independent online experts, which evaluate the project on ICO listing websites (Fenu et al. 2018; ICObench 2019). As recent research calls suggest, we lack knowledge about the impact of third-party support on operational value creation at ICO ventures (Fisch 2019). In particular, third-party endorsement might have a positive signaling effect, not only on the fundraising outcome but also on the operations of a venture, such as the development process.

During their campaigns, many ICO ventures provide a link to their profile on the public web-hosting platform GitHub, where they conduct their software development project. This open innovation strategy enables the crowd to review the source code and contribute to the project (Adhami et al. 2018; Fisch 2019). Widely-cited research on co-creation emphasizes the importance of co-creation with customers or end-consumers and agrees that the potential advantages of including customers' knowledge are extensive (Gemser and Perks 2015; Tseng and Chiang 2016; Zwass 2010). Small firms may compensate for a lack of own resources through co-creation with customers in their new product development (NPD) process. However, it remains that few studies examine customer involvement from the perspective of young ventures (Chang and Taylor 2016; Stanko et al. 2017; West et al. 2014). The question thus arises which antecedents relate to crowd engagement at early-stage ventures and why certain open source software projects retrieve more input from the crowd than others.

In a wider context, the reasons why individuals help others through their participation in online networks has been investigated by studies in the domain of open source communities. Research found that the participation of the crowd in NPD projects is motivated by reward factors, which include financial gains, recognition or joy (Hertel et al. 2003; Lakhani and Wolf 2003; Tran et al. 2012). We will extend this concept in the light of signaling theory. We argue that participation in co-creation requires time and effort of the crowd participants, which are costs they spend on contributing to the software project before receiving such rewards. Accordingly, we expect that crowd members evaluate a project before investing (time and effort) in supporting it. We argue that this decision is comparable to the investment decision in crowdfunding, where many supporters make small contributions to a project (Short et al. 2017).

Signaling theory (Spence 1973) is used to explain which type of information leads investors to invest in startups. To be effective, signals need to be observable and costly to be generated or imitated (Connelly et al. 2011). Crowdfunding research suggests that third-party certification is associated with increased crowdfunding success via online funding mechanisms (Courtney et al. 2016; Mollick 2013). First studies in the ICO context investigating ICO fundraising success also posit that third-party endorsement signals via online channels (like ICO listing websites, social media websites) positively influence the reaction of investors (Blaseg 2018; Guske and Bendig 2018). Subsequently, we would expect a positive relation between third-party support of ICO ventures and crowd participation in open source development.

In contrast, goal pursuit literature in the context of crowdfunding shows that crowd participation also depends on the perception that their contribution will make a considerable impact. The motivation of the crowd to engage decreases after a project has achieved a certain target as the marginal contribution of their individual support is reduced (Kivetz et al. 2006; Kuppuswamy and Bayus 2017). Applying this logic to crowd engagement in software co-creation, we would expect third-party support to be negatively associated with crowd participation because higher third-party support reduces the marginal value-add of additional contributions.

Based on those literature streams, we find arguments for both a positive and a negative association between advisor support and crowd participation. Regarding the total amount of advisor support, we follow studies from open source communities. We hypothesize that a higher amount of advisor support is positively associated with crowd participation.

H1: Advisor support is positively related to crowd participation in software development.

While we generally expect a positive relation between advisor support and crowd participation, we argue that there might be a more fine-grained pattern depending on the type of advisor support. Signaling research revealed that certification effects can vary between different types of affiliates (Connelly et al. 2011; Pollock et al. 2010). In the ICO context, this argument can be tested as most ventures provide investors with information about the background of their advisors. We follow studies which investigate team characteristics in new technology-based firms and differentiate the ICO advisors based on their formal education – being either technical and scientific or economic and managerial (Colombo and Grilli 2005).

On the one hand, we argue that advisors with technology education signal that the firm intends to create an advanced development project. Based on the arguments from open source communities and crowdfunding, we would predict that more tech advisors are related to more crowd engagement, as they can provide reward factors to the crowd participants. On the other hand, according to goal pursuit theory, we could also expect a negative association between number of tech experts and crowd participation. A higher extent of tech experts might reduce the perceived marginal contribution of a crowd participant and thus reduce the motivation to engage. The reverse argumentation applies to business advisors, who signal a venture´s focus on the economic aspects of a project.

Since the arguments from open source community research and goal pursuit literature contradict each other, we test the positive relation to evaluate which theory holds in our context. We hypothesize:

H2a: The extent of advisor support with business education is positively related to crowd participation.

H2b: The extent of advisor support with technology education is positively related to crowd participation.

Besides internal supporters like ICO advisors, there are external ICO supporters such as independent online experts. One of the leading platforms for ICO campaigns is ICObench.com, where registered online experts evaluate the ICO projects (Fenu et al. 2018; ICObench 2019). Crowdfunding research shows that comments

from the crowd are positively associated with funding success (Butticè et al. 2017). While this study assumes that comments are mainly positive in nature, we will take a more focused approach and only consider positive expert evaluations for our analysis. We argue that projects which receive a higher amount of positive evaluations during the ICO have higher external third-party support. High external support might signal to the crowd participants that it is worth investing time in the project, as it is seen favorably by the community of experts, who might in turn provide positive reward factors. Following this argumentation, we formulate:

H3: External third-party support is positively related to crowd participation in software development.

Previous studies show that the signaling value of third-party supporters depends on their prestige in the relevant community. We know from research in the IPO and crowdfunding context, that high status affiliates or supporters with more reputation increase the probability of attracting financing from the crowd. Those studies follow the concept that more reputation is associated with a larger network (social capital) and more experience (Courtney et al. 2016; Lee et al. 2011; Pollock et al. 2010). We derive that the crowd in the co-creation environment might also be influenced by an online expert´s reputation in the industry. Thus, we expect that the reputation of the external third-party support moderates the relationship between external third-party support and crowd participation. We hypothesize:

H4: The relation between external third-party support and crowd participation is positively moderated by the reputation of the related external third-party.

Study Setting and Data

To test our hypotheses, we created a unique dataset of 697 firms which conducted a successful ICO between 2015 and October 2018 and have a public profile for software development on GitHub. We collected data about the ICO venture, their third-party support (ICO advisors and independent online experts) and crowd participation from three main sources: ICO listing websites (ICObench.com), LinkedIn and the venture´s GitHub profiles. We use data from ICObench and GitHub as they are accessible online to the public. They provide an overview of current and past ICO projects (including their open innovation activity) and were used by earlier studies in the field of ICOs (Fenu et al. 2018; Fisch 2019) or IS (Dabbish et al. 2012; Vasilescu et al. 2015). On ICObench, ICO ventures provide links to the LinkedIn profiles of their team members and advisors. Based on these links, we collected data of >2,700 LinkedIn profiles. LinkedIn has been shown by various scholars to be an eligible source of data for research about individuals´ experiences and educational backgrounds (Baruffaldi et al. 2017; Homburg et al. 2014). We captured the data from the sources named above through web scraper tools, which we created for this research purpose. An overview of the data sources is displayed in Figure 1.

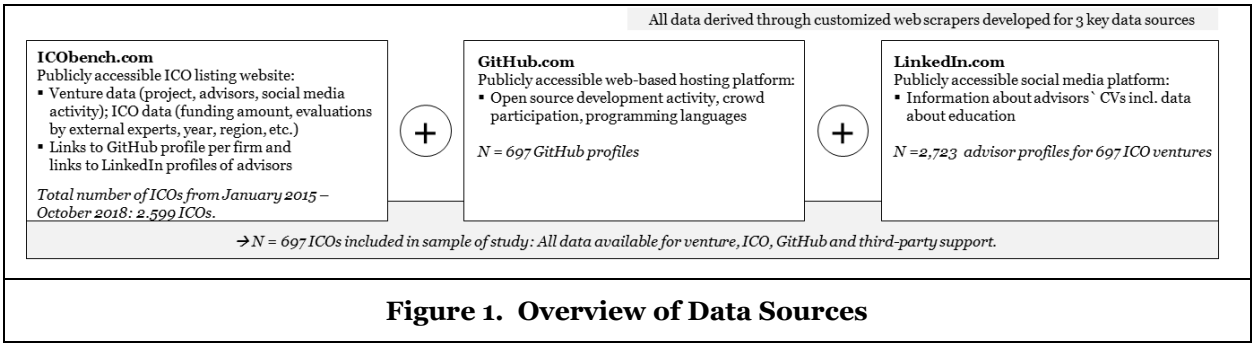

Figure 1. Overview of Data Sources

The dependent variable crowd participation measures the crowd input for each project on GitHub. GitHub provides the opportunity to analyze code-related activity of software development projects. The firm profiles are organized in folders (repositories), which include the source code, commit history and other data about the project. Project owners can modify the code or make changes via commits. Crowd participants without commit rights can submit changes to the project via pull requests. The project owners can then merge the suggested pull requests to the project (Dabbish et al. 2012; Vasilescu et al. 2015). For the ICOs in our sample, we use the total number of pull requests for all repositories that each project

received from the crowd – an approach which we adjusted from previous studies on customer participation (Nambisan and Baron 2009). We use the logarithm of the number of pull requests to account for the skewed distribution of values (Log_CrowdParticipation).

The independent variables operationalize the internal and external third-party support of each ICO venture. First, we count the number of ICO advisors of each venture (Number of Advisors). We then collect the number of advisors with business education (Internal support: Business Advisors) or technology education (Internal support: Tech Advisors) per firm. We code the individual advisor based on their university degree (which we derived from LinkedIn), an adapted approach based on previous studies (Colombo and Grilli 2005; Mohammadi et al. 2017). Our fourth independent variable is external third-party support, which we measure as the number of positive evaluations (minimum grade of 4 on the scale from 1 to 5), that the firm received on ICObench by ICO experts (External Support: Positive Evaluations). According to studies in the venture capital context, we measure reputation of the online experts as the number of ICOs they are affiliated with (External Support: Reputation) (Lee et al. 2011; Pollock et al. 2010).

We include control variables to account for firm and industry specifics. We control for the funding amount that the firm raised in the ICO. We collected the amount in USD from ICObench (Log_FundingSum) (Fisch 2019). We control for the size of the ICO team (TeamSize), as a bigger team might have a larger network in the respective field and therefore receive more crowd engagement (Ahlers et al. 2015). As certain firms may generally be less interested in interaction with the crowd, we control for the number of social media accounts (SocialMediaActivity) per ICO venture (Jin et al. 2017). Not all ICO ventures might have a focus on developing a relevant part of their project on GitHub or conducting co-creation with the crowd. Therefore, we control for the general open source development activity (OpenSource_DevelopmentActivity) per firm, which we measure by the number of repositories (folders) that a firm created on GitHub. ICOs are a recent phenomenon with national regulations still being adapted. In countries like USA or China participation in certain ICOs is not allowed (Amsden and Schweizer 2018). Accordingly, we include a dummy variable to control for regional restrictions (Restricted_Area_Dummy). We include a dummy variable which reflects whether a firm uses the Ethereum blockchain (Platform_Ethereum_Dummy), as using this standard could impact the development activity by the crowd. We additionally control for the programming language mainly used in the project (e.g. ProgrLanguage_JavaScript) and include dummy variables for sectors (e.g. Sector_Finance) and time following previous ICO research (Ahlers et al. 2015; Amsden and Schweizer 2018; Fisch 2019).

Results

The 697 ICOs in our sample received a total of 93,250 pull requests from the crowd with a mean of 133 pull requests per firm (mean of the logged variable = 1.61). On average, the ICOs have 5.2 advisors, thereof 2.0 with business education and 1.3 with technology education. The ICO ventures received on average 4.96 positive evaluations from external supporters and raised on average ~17 Mio. USD (mean of the logged variable = 15.08) during their campaign.

To test our hypotheses, we calculated six ordinary least squares (OLS) regression models with robust standard errors using the statistics software Stata. We standardized all variables to account for differences in scales. The results are displayed in Table 1. Model 0 contains only the control variables and reveals that the ICO funding amount, the general activity on GitHub, certain programming languages and the region *USA* are significantly and positively related to crowd engagement. Model 1 and 2 test the relation between internal third-party support and crowd participation. We reject hypothesis 1, as we find that the number of advisors is not significantly associated with crowd participation ($\beta = -0.0742$, $p > 0.1$). However, the variables for advisor support with business and technology education are significant. Surprisingly, we find internal support by business advisors to be negatively associated with crowd participation ($\beta = -0.2550$; $p < 0.01$) and reject hypothesis 2a. We confirm hypothesis 2b, as the relation between tech advisors and crowd participation is significantly positive ($\beta = 0.2380$, $p < 0.01$). As the dependent variable is logarithmic, we need to consider the exponentiated coefficients when interpreting effect sizes. Accordingly, the exponentiated coefficient of tech advisors can be transformed to +1.269.

Model 3 and 4 test the relation between external third-party support and crowd participation as well as the interaction. We reject hypothesis 3 because external support is not significantly associated with crowd participation ($\beta = 0.0507$, $p > 0.1$). Hypothesis 4 states that the relation between external support and crowd

participation is positively moderated by the reputation of the external support. Contrary to our initial hypothesis, we find the relation between external support of ICO ventures and crowd participation to be negatively moderated by reputation (β = -0.0667, p <0.01). Finally, model 5 includes all independent and moderating variables. The coefficients remain significant and stable in their direction. Figure 2 summarizes the results for each hypothesis.

Table 1. OLS Regression Results - Dependent Variable: Log_CrowdParticipation

Variables	Model 0	Model 1	Model 2	Model 3	Model 4	Model 5
Internal support: Number of Advisors		-0.0742				-0.127
		(0.0672)				(0.109)
Internal support: Business Advisors			-0.255***			-0.228**
			(0.0888)			(0.103)
Internal support: Tech Advisors			0.238***			0.265***
			(0.0900)			(0.0998)
External Support: Positive Evaluations				0.0507	0.350**	0.374**
				(0.0673)	(0.170)	(0.171)
External Support: Reputation					-0.122	-0.0808
					(0.136)	(0.137)
External Support: Positive Evaluations x Reputation					-0.0667***	-0.0763***
					(0.0247)	(0.0257)
Log_FundingSum	0.422***	0.427***	0.419***	0.421***	0.405***	0.409***
	(0.0592)	(0.0595)	(0.0589)	(0.0593)	(0.0589)	(0.0587)
TeamSize	0.0376	0.0529	0.0522	0.0296	0.0204	0.0469
	(0.0742)	(0.0766)	(0.0746)	(0.0756)	(0.0754)	(0.0760)
SocialMediaActivity	-0.123	-0.108	-0.112	-0.136*	-0.146*	-0.133
	(0.0801)	(0.0813)	(0.0815)	(0.0818)	(0.0826)	(0.0836)
OpenSource_DevelopmentActivity	1.111***	1.105***	1.100***	1.109***	1.107***	1.087***
	(0.211)	(0.211)	(0.210)	(0.211)	(0.210)	(0.208)
Platform_Ethereum_Dummy	-0.169	-0.155	-0.187	-0.178	-0.181	-0.192
	(0.254)	(0.251)	(0.252)	(0.255)	(0.257)	(0.252)
Restricted_Area_Dummy	0.193	0.195	0.184	0.193	0.182	0.176
	(0.146)	(0.146)	(0.144)	(0.146)	(0.146)	(0.144)
Constant	0.970***	0.962***	0.976***	0.980***	1.044***	1.062***
	(0.323)	(0.321)	(0.318)	(0.323)	(0.326)	(0.321)
Observations	697	697	697	697	697	697
Adjusted R-squared	0.442	0.442	0.447	0.441	0.444	0.451

Note: *** p<0.01, ** p<0.05, * p<0.1; robust standard errors in parentheses; all variables standardized; controls for sector, year, programming language and region included in all models

Table 1. Regression Results

To assess the robustness of our findings, we tested for multicollinearity by calculating the variance inflation factors (VIF) for the models 0 – 5. The average (1.38-1.98) and maximum (6.7) VIFs are lower than the threshold of ten indicated by O´Brien (O'Brien 2007). We conclude that the results do not seem to be influenced by multicollinearity. We also calculated the OLS regression results for all models with non-standardized variables. All our effects and significance levels remain robust.

Hypotheses	Result
H1: Advisor support is positively related to crowd participation in software development.	rejected
H2a: Extent of advisor support with business education is positively related to crowd participation.	highly significant, but negative
H2b: Extent of advisor support with technology education is positively related to crowd participation.	confirmed
H3: External third-party support is positively related to crowd participation in software development.	rejected
H4: The relation between external third-party support and crowd participation is positively moderated by the reputation of the related external third-party.	highly significant, but negative

Figure 2. Summary of Results

Conclusion and Discussion

In this study, we provide empirical evidence for the link between third-party endorsement by internal as well as external supporters and crowd participation at young ventures. We empirically validate our hypotheses with a multi-source secondary dataset of 697 ICO ventures which published their source code online. Our study advances knowledge on IS and open innovation literature in several ways.

Firstly, our study enhances the understanding of antecedents of software co-creation and provides a nuanced picture of how internal and external third-party endorsement is related to crowd participation in new product development. We apply signaling theory beyond the fundraising campaign. Previous studies in crowdfunding and ICO literature focus on investigating signals as antecedents of funding success and reveal that third-party endorsement signals influence the crowd of investors (Calic and Mosakowski 2016; Fisch 2019; Guske and Bendig 2018). Building on these insights, we find third-party endorsement signals to be related with crowd participation in open innovation. This result indicates that displaying third-party endorsement is not only relevant for fundraising, but the signals also unfold their effect beyond the fundraising campaign. On top, we provide an empirical real-world study with an objective performance measure of co-creation at early-stage ventures and answer current research calls (Gemser and Perks 2015).

Secondly, by differentiating between two groups of third-party support at ICOs we offer insights into the signaling effects originating from advisors and ICO experts. Previous ICO and crowdfunding studies in the light of signaling theory find that online signals of ICO ventures influence crowd behavior with regard to financing decisions (Blaseg 2018; Courtney et al. 2016; Guske and Bendig 2018). Accordingly, we argue that displaying certain third-party support might consequently influence crowd support in open source projects. We find that the signaling effect of internal supporters differs depending on the advisors´ background. Tech advisors are positively related to crowd participation. For the online developer community, it might be more interesting to engage in projects with technology expertise. This can be further supported by arguments from IS literature on open source communities (Hertel et al. 2003), as qualified technology advisors might provide the crowd participants reward factors like positive feedback and recognition. This supports the idea that the online crowd in the ICO context is mainly driven by technological and ideological motives, and that technically skilled crowd participants rather follow tech advisors. Business support seems to crowd out voluntary supporters in this online community. The crowd´s interest in supporting voluntarily might decline if ventures signal higher focus on economic aspects of open source projects. Moreover, we find that the effect of external support is influenced by the reputation of the external support. Firms with prestigious external support show less crowd participation. The crowd might get the perception that their support does not make a considerable contribution, which reduces the motivation to engage. This insight underscores findings from goal pursuit literature as well as crowdfunding campaigns (Colombo et al. 2014; Kuppuswamy and Bayus 2017) and highlights the relevance of achievement motivation in addition to technological and ideological motives.

Thirdly, we contribute to the emerging ICO research stream, which provides new opportunities for studying early phases of ventures and their product development process. Besides its scholarly importance, this study provides implications for practitioners. We recommend that firms make an active decision about their development and signaling strategy. We encourage entrepreneurs to decide whether they favor retrieving input from advisors and online experts or the crowd for development projects. At the same time, investors should reflect which impact signals of third-party support might have beyond the financing campaign.

Limitations and Further Avenues for Research

Our study contains limitations that provide avenues for further research. ICOs are still a recent phenomenon and currently the time frame of available data is limited. Future studies could empirically examine time series data and shed light on the causality assumption. Furthermore, our multi-sourced dataset focuses on firms which published code on GitHub and successfully conducted an ICO. This might lead to the fact that our analysis does not cover specific aspects of firms which use a different system for their software project or did not conduct a successful ICO. Finally, we consider the amount of crowd input as measure for crowd participation and do not reflect the quality behind this input. Investigating this quality aspect or even the resulting market success would enable further insights regarding the advantages of third-party support.

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